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Research Note

Effect of Food Quality on Growth of the Ornamental Fish Koi carp, *Cyprinus carpio carpio* (var)

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The growth rate of an organism depends mainly on the right choice of food which provides all the nutrients. Previous authors have studied the effect of feed types on food intake and growth of cultivable fishes (Jobling, 1983; Bengtson *et al.*, 1991; James *et al.*, 1993). Less attention has been paid on the study of the effect of feed types on feed consumption and growth of tropical ornamental fish (Akilan & Kumaran, 2003; James & Sampath, 2004). Koi carp, *Cyprinus carpio carpio* is relatively new in ornamental fish culture. The present paper reports on the effect of feed types on growth in koi carp, *Cyprinus carpio carpio.*

Healthy and active *C. carpio carpio* juveniles (30 days old; 2.17±0.33 g wet weight) were collected from the laboratory bred same brooders. They were grouped into five of 25 individuals each, and reared in circular cement tanks (Diameter : 60 cm × height : 45 cm) containing 75 l of water. Triplicates were maintained for each group. The clean unchlorinated well water was used and physico-chemical parameters were monitored biweekly. Temperature averaged to 27.5 ± 1°C, pH 7.7 ± 0.05; salinity 0.11 ± 0.1 ppt, hardness 323 ± 10 mg $CaCO_3$ l^{-1}, DO 4.12 ± 0.5 ppm and ammonia 1.05 ± 0.12 mg l^{-1}. The tanks were drained twice a week and replenished with freshwater to remove faeces accumulated at the bottom of the tanks.

Clam meal, beef liver, chicken intestine, pelleted feed (36% protein) and mixed diet (each of the above feeds in equal proportions) were chosen as the experimental feeds. Clams (*Villorita cyprinoides*) were collected from the nearby marine shores once in two days and maintained in a cement tank containing marine beach soil and sea water. Before feeding to fish, the clams were wet shucked and washed 3-5 times in freshwater. Beef liver and chicken intestine (cleaned and faeces removed) were procured from local market and stored in the refrigerator at 4°C. Clam meal, beef liver and chicken intestine were minced and traces of water were removed by pressing the minced pieces between folds of filter paper. Pelleted feed (36% protein) was prepared following the square method (Hardy, 1980).

Feed was weighed and given *ad libitum* in a feeding tray daily at 08.00 and 16.00 h for two hours. Unconsumed feed was collected and dried in a hot air oven at 80°C. Feed consumption was estimated by subtracting the weight of the unconsumed dry feed from the weight of the feed offered on dry weight basis. The feeding rate was computed as:

$$\text{Feeding rate (mg g}^{-1}\text{ fish day}^{-1}) = \frac{\text{Feed consumed (mg)}}{\text{Initial weight of fish (g) x No. of days}}$$

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Fish, feed samples and unconsumed feed were weighted in an electrical monopan balance to an accuracy of 1 mg.

The "sacrifice method" was adopted to estimate the growth of the test individuals (Maynard & Loosli, 1962). Growth or feed conversion was calculated by subtracting the initial dry weight from the final dry weight. The growth rate, gross conversion efficiency and food conversion ratio (FCR) were calculated as:

$$\text{Growth rate (mg g}^{-1}\text{ fish day}^{-1}) = \frac{\text{weight gain (mg)}}{\text{Initial weight of fish (g) x No. of days}}$$

$$\text{Gross conversion efficiency (\%)} = \frac{\text{Weight gain (mg)}}{\text{Feed consumed (mg)}} \times 100$$

$$\text{Feed conversion ratio} = \frac{\text{Total feed intake (g, dry matter)}}{\text{Total wet weight gain (g)}}$$

The experiment lasted for 60 days. Protein and lipid content of feeds were estimated following the method of Lowry *et al.* (1951) and Bradgon (1951). Mineral content of feeds was estimated by adopting the method of Paine (1964). Nitrogen free extract (NFE) was calculated by subtraction of the protein, fat and mineral contents from the dry weight of the feed samples. Student's 't' test was applied to determine the significance of mean values between the different experimental groups.

Protein content was maximum in both mixture diet and clam meal followed by other three diets. However, nitrogen free extract was more in chicken intestine and liver than in other diets (Table 1).

The results showed that feed types had significant effect on the feed consumption and growth in koi carp, *C. carpio carpio*. Fish fed with pellet feed elicited higher feed consumption and feeding rate than those fed with other experimental diets; but an opposite trend was obtained in conversion rate and efficiency (Table 2). Among the feed types, fish fed with chicken intestine showed high rate and efficiency of conversion followed by fish fed with mixed diet and beef liver. Fish fed with mixed diet and chicken intestine elicited the better performance of FCR value than other diets. However, there was no significant ($t = 1.81$; $P > 0.05$) difference in FCR value between groups fed with chicken intestine (2.22) and mixed diet (2.13).

The mixed diet promoted better growth rate at low feeding rate perhaps due to the presence of different components, stimulating growth with required composition of protein (36%) and nitrogen free extract (42%). Nandeesha *et al.* (1994) and James & Sampath (2004) reported that mixed feeding schedules were superior to single high protein schedules as nitrogen retention was higher in the fish fed with the mixed schedules. Although chicken intestine had low protein content (34.40%) than pellet feed and clam meal, it performed better with higher growth rate and FCR than those fed

Table 1. Proximate composition (%) of experimental diets

Parameters	Clam meal	Liver	Chicken intestine	Pellet feed	Mixture diet
Crude protein	39.60±3.12	35.70±2.52	34.40±2.80	35.60±1.20	39.80±2.90
Crude fat	17.40±0.80	3.90±0.10	2.30±0.10	5.32±0.30	6.20±0.04
Ash	11.10±1.00	8.90±0.70	10.20±0.50	16.00±0.30	12.20±1.10
Nitrogen Free Extract (NFE)	31.90±2.50	51.50±3.70	53.10±4.30	43.10±3.90	41.80±4.10

Table 2. Effect of different feeds on the selected feeding parameters in Koi carp, *Cyprinus carpio carpio*. Each value is the mean ($\bar{X} \pm SD$) of three observations

Parameters	Feed types				
	Clam meal	Liver	Chicken intestine	Pellet feed	Mixed diet
Feed consumption (g dry matter)	21.80 ± 0.01	24.70 ± 0.03	23.48 ± 0.11	55.08 ± 0.07	24.86 ± 0.07
Initial weight (g dry matter)	0.56 ± 0.02	0.58 ± 0.04	0.56 ± 0.01	0.71 ± 0.01	0.75 ± 0.01
Final weight (g dry matter)	2.80 ± 0.13	3.88 ± 0.25	4.21 ± 0.18	4.09 ± 0.39	4.92 ± 0.36
Feed conversion (g dry matter)	2.24 ± 0.09	3.30 ± 0.40	3.65 ± 0.03	3.38 ± 0.07	4.17 ± 0.32
Feeding rate (mg g^{-1} day^{-1})	190.30 ± 15.50	207.60 ± 5.40	205.30 ± 10.57	374.40 ± 12.02	160.01 ± 1.30
Conversion rate (mg g^{-1} day^{-1})	14.60 ± 0.80	22.80 ± 2.40	27.00 ± 2.16	18.14 ± 0.20	22.00 ± 2.30
Conversion efficiency (%)	7.69 ± 0.21	11.00 ± 1.06	13.13 ± 0.43	4.85 ± 0.10	13.75 ± 1.10
Feed conversion ratio	3.78 ± 0.09	2.67 ± 0.04	2.22 ± 0.07	6.00 ± 0.01	2.13 ± 0.02

Student's 't' test

Conversion rate	=	Chicken intestine Vs mixed diet	:	t = 1.81; P > 0.05
		Chicken intestine Vs liver	:	t = 1.84; P > 0.05
		Mixed diet Vs liver	:	t = 0.35; P > 0.05
Conversion efficiency	=	Chicken intestine Vs mixed diet	:	t = 0.75; P > 0.05
		Chicken intestine Vs liver	:	t = 2.66; P < 0.05
		Mixed diet Vs liver	:	t = 2.57; P < 0.05
Feed conversion ratio	=	Chicken intestine Vs liver	:	t = 8.83; P < 0.05
		Mixed diet Vs liver	:	t = 18.0; P < 0.05
		Chicken intestine Vs mixed diet	:	t = 2.25; P < 0.05

with clam meal and pellet feed. This may be due to the softness, palatability and higher nitrogen free extract of chicken intestine, which provided energy for fish growth. The poor growth rate observed in fish fed with the pellet feed suggests that pellets are not suitable to juvenile koi carp, *C. carpio carpio*. Degani (1991) and James & Sampath (2004) found that juveniles of *Trichogaster trichopterus* and *Xiphophorus helleri* fed with live feed grew faster than those fed with formulated feed because of the palatability, high consumption and chemical composition of the live feed. Although fish fed with clam meal elicited the high feeding rate, (170 mg g^{-1} live fish day^{-1}), it resulted in reduction of conversion rate (14.6 mg g^{-1} live fish day^{-1}) and efficiency (7.69%) by two times as compared to fish consuming chicken intestine (see Table 2). This suggests that clam meal did not have any stimulatory effect on growth in koi carp. Based on the present study, the mixed diet or chicken intestine, followed by beef liver and clam meal diet, were found most suitable to increase growth in koi carp, *C. carpio carpio*.

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